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SHRIMP TRAWL EXPERIMENTS IN THE GULF OF THAILAND, USING DIFFERENT TYPES OF NET (1983-1984)

Shigeo HAYASE, Suppachai ANANPONGSUK, Aussanee MUNPRASIT, Somnuk PORNPATIMAKORN, Udom PITTAYANANTAKIT, Masato OISHI and Tomeyoshi YAMAZAKI

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Training Department
Southeast Asian Fisheries Development Center

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INTRODUCTION

Since the introduction of otter-board trawl in 1961, there has been a rapid development of fishery production in Thailand. The excessive use of otter-board trawl has, however, resulted in over-fishing and depletion of demersal resources especially in coastal areas of the Gulf of Thailand, where the catch of a day's trawling may contain as many as 100 species or more, including a large number of shrimp species. This shows that, in such multispecies trawl fisheries, incidental catches may lead to depletion of non-target species. For example, shrimp trawl fishery, which is generally operated in coastal areas with small-sized baby trawlers less than 14 m in length, has been accused of killing significant numbers of juventiles/young of economical important fish species.

The depletion of demersal resources may be caused by increased fishing intensity in terms of fishing effort (which includes improved net design, smaller mesh size and adjustment of the operation system both in space and time for better catches etc.). In such a situation, fishing control measures should be considered with regard to trawl fishery. It has also become necessary to investigate the effects of shrimp trawl nets on incidental catches, with a view to preventing the capture of juveniles or young of economically important species.

The SEAFDEC Training Department therefore initiated shrimp trawl experiments. The planning of these experiments was done by Mr. T. Yamazaki, one of the authors of this report. The experiments themselves were carried out by other Department staff as member of the survey team, and the present report was compiled by Dr. S. Hayase, member of the Research Division of the Training Department, SEAFDEC.

In this study, experimental shrimp trawls by different types of net have been attempted to establish the catch composition by animal groups in different fishing areas. Very little catch data by different nets is available for the evaluation of the catching efficiency for shrimp. Furthermore, there is a lack of information on the reaction of marine animals. For example, the behaviour of marine animals in response to net operations cannot yet be definitely established. Therefore the present study is limited to an estimation of catch selectivity by different types of net.

MATERIALS AND METHODS

Three series of shrimp trawl experiments on board M.V. PLALUNG were conducted from 19 to 23 August and 11 to 15 Novemver 1983, and from 9 to 13 April 1984 (Table 1). The conditions of operation of these experiments are given in Table 2.

The three types of shrimp trawl net, i.e., two seam, four-seam, and two-seam commercial nets, were used. Each of these was of the ordinary type without a window and of a special design with a window, as shown in Figure 1. During operations, the three types of net with window and without window were used alternately to compare the catching efficiency for shrimp of the six different net designs.

Two kinds of otter board, as illustrated in Figure 2, were also used.

The three areas (Area I, Area II and Area III) for experimental trawling are shown in Figure 3.

All hauls were done after one hour's towing between 4.00 p.m. and 7.00 a.m., and these operation times were divided into three time units, i.e. evening, night and morning.

Table 1. Fishing time and type of net used in the shrimp trawl experiments by area.

Operation	Fishing Time	Type of net			
		1	2	3	4
1st experiment 19-23 August 1983 Area I	M_1	N_1 N_4	N_2	N_2 N_3	-
	M_2	N_4 N_4	N_1	N_3 N_3	-
	M_3	N_4	N_1	N_2 N_2	-
2nd experiment 11-15 November 1983 Area II	M_1	N_3 N_3	N_4 N_4	N_1 N_1	N_2 N_2
	M_2	N_3 N_3	N_4 N_4	N_1 N_1	N_2 N_2
	M_3	N_3 N_3	N_4 N_4	N_1 N_1	N_2 N_2
3rd experiment 9-13 April 1984 Area III	M_1	N_5 N_5	N_3	N_1 N_1	-
	M_2	N_6 N_6 N_5 N_5	N_3 N_4 N_4 N_3	N_2 N_2 N_1 N_1	-
	M_3	N_6 N_6	N_3 N_4 N_4	N_2 N_2	-

N_1 = 2 W.O. (2-seam net without window)

N_2 = 2 W.W. (2-seam net with window)

N_3 = 4 W.O. (4-seam net without window)

N_4 = 4 W.W. (4-seam net with window)

N_5 = 2 C.W.O. (2-seam commercial net without window)

N_6 = 2 C.W.O. (2-seam commercial net with window)

M_1 = Evening

M_2 = Night

M_3 = Morning

Table 2 Conditions of operation of the shrimp trawl experiments by area

a) 1st experiment, 19-23 August 1983

Period	Fishing Time	Operation	Time	Depth (m)	Warp (m)	Towing Direction	Type of net
19-21 August Area I	M_1	1	1705 - 1805	17	100	180°	N_1
		2	1900 - 2000	12-14	100	270°	N_4
	M_2	3	2045 - 2145	13	100	010°	N_4
		4	2205 - 2305	12	100	180°	N_4
	M_3	5	0405 - 0505	12	100	000°	N_4
21-22 August Area I	M_1	6	1720 - 1820	12-15	100	050°	N_2
	M_2	7	0300 - 0400	15	100	050°	N_1
	M_3	8	0550 - 0650	16-21	100	180°	N_1
22-23 August Area I	M_1	9	1705 - 1805	12	100	055°	N_2
		10	1835 - 1935	14-15	100	080°	N_3
	M_2	11	2020 - 2120	15	100	220°	N_3
		12	2130 - 2230	14	100	220°	N_3
	M_3	13	0235 - 0335	12	100	015°	N_2
		14	0440 - 0540	13-14	100	320°	N_2

Table 2. (continued)

b) 2nd experiment, 11-15 November 1983

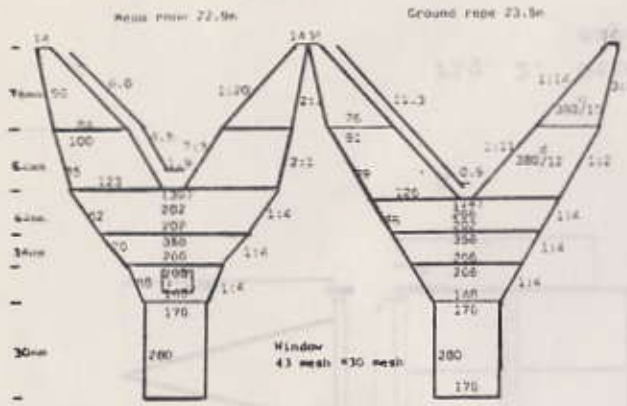
Period	Fishing Time	Operation	Time	Depth (m)	Warp (m)	Towing Direction	Type of net
11-12 November Area II	M_1	1	1600 - 1700	19.5-12	100	270°	N_3
		2	1725 - 1825	19.5-20	100	270°	N_3
	M_2	3	1850 - 1950	19-19.5	100	060°	N_3
		4	0315 - 0415	18	100	000°	N_3
	M_3	5	0440 - 0540	16	100	000°	N_3
		6	0615 - 0715	17-15	100	180°	N_3
12-13 November Area II	M_1	7	1600 - 1700	17-18	100	270°	N_4
		8	1725 - 1825	18	100	270°	N_4
	M_2	9	1845 - 1945	17-18	100	090°	N_4
		10	0305 - 0405	16-19	100	180°	N_4
	M_3	11	0430 - 0530	17	100	000°	N_4
		12	0550 - 0650	16.5-18	100	160°	N_4
13-14 November Area II	M_1	13	1625 - 1725	22-23.5	100	200°	N_1
		14	1750 - 1850	22	100	050°	N_1
	M_2	15	1910 - 2010	21-22	100	270°	N_1
		16	0310 - 0410	16-18	100	090°	N_1
	M_3	17	0430 - 0530	18-20	100	160°	N_1
		18	0545 - 0645	18-19	100	100°	N_1
14-15 November Area II	M_1	19	1550 - 1650	16	100	020°	N_2
		20	1705 - 1805	15	100	180°	N_2
	M_2	21	1820 - 1920	17-20	100	270°	N_2
		22	0245 - 0345	20-22	100	180°	N_2
	M_3	23	0405 - 0505	18-20	100	180°	N_2
		24	0550 - 0650	19	100	180°	N_2

Table 2. (continued)

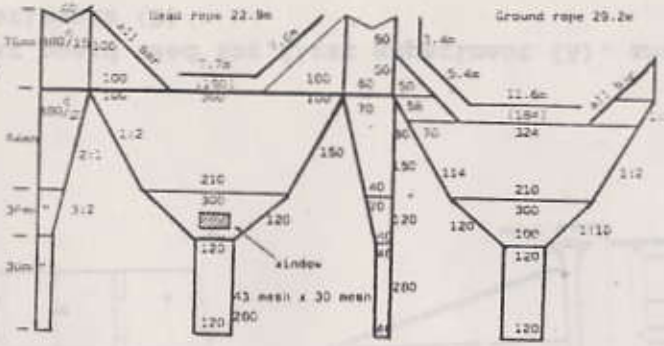
c) 3rd experiment, 9-13 April 1984

Period	Fishing Time	Operation	Time	Depth (m)	Warp (m)	Towing Direction	Type of net
9-10 April Area III	M_1	1	1755 - 1855	24-25	150	210°	N_5
		2	1930 - 2030	25	150	210°	N_5
	M_2	3	2100 - 2200	24	150	210°	N_6
		4	2230 - 2330	21-22	150	220°	N_6
		5	0000 - 0100	20	150	235°	N_5
		6	0130 - 0230	18-22	150	055°	N_5
	M_3	7	0300 - 0400	22	120	080°	N_6
		8	0425 - 0525	25	120	110°	N_6
11-12 April Area III	M_1	9	1925 - 2025	26	120	245°	N_3
	M_2	10	2050 - 2150	22-24	130°	245°	N_3
		11	2200 - 2300	21-22	130°	245°	N_4
		12	2310 - 2410	20	130°	205°	N_4
		13	0135 - 0235	20	130°	200°	N_3
	M_3	14	0255 - 0355	20	130°	200°	N_3
		15	0415 - 0515	24	136°	045°	N_4
		16	0545 - 0645	25	136°	045°	N_4
12-13 April Area III	M_1	17	1820 - 1920	22	136°	340°	N_1
		18	1955 - 2055	22	136°	330°	N_1
	M_2	19	2110 - 2210	19	136°	330°	N_2
		20	2225 - 2325	17	136°	330°	N_2
		21	0000 - 0100	15	136°	320°	N_1
		22	0115 - 0215	15	136°	330°	N_1
	M_3	23	0240 - 0340	12	136°	310°	N_2
		24	0400 - 0500	10	136°	310°	N_2

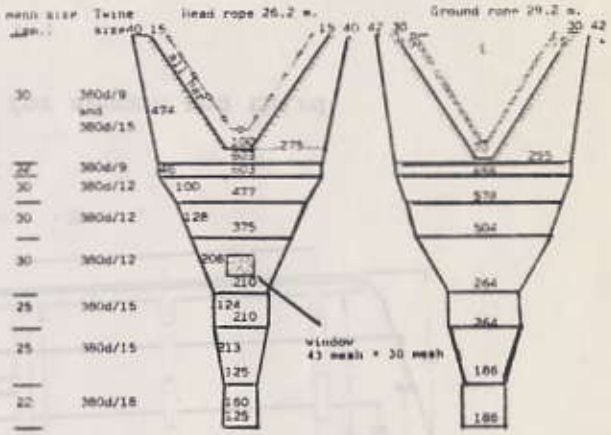
Two-seam net



Four-seam net



Two-seam commercial net



Particulars

Net / Components	Two seam type	Four seam type	Two seam Local fisherman type
Head rope	22.5 m	22.8 m	26.2 m
Ground rope	23.5 m	29.2 m	29.2 m
Buoy (Plastic)	ø 24 cm round type buoyancy 5 kg/P'ce (12 P'ces)	ø 24 cm round type buoyancy 5 kg/P'ce (12 P'ces)	ø 15 cm round type 1 P'ce 16x10x35 cm (Synthetic rubber) cylindrical shape 10 P'ces
Chain	1.5 kg/m (23.5 m)	1.5 kg/m (29.2 m) 1.5 kg/m (6.1 m) length of chain attached to center of net	0.7738 kg/m (42.0 m) 0.7738 kg/m (4.0 m)
Sinker	-	6 kg each, sinkers attached to both ends of ground rope	-
Window	43x30 mesh	43x30 mesh	43x30 mesh

Fig. 1. Design and particulars of nets used in the shrimp trawl experiments.

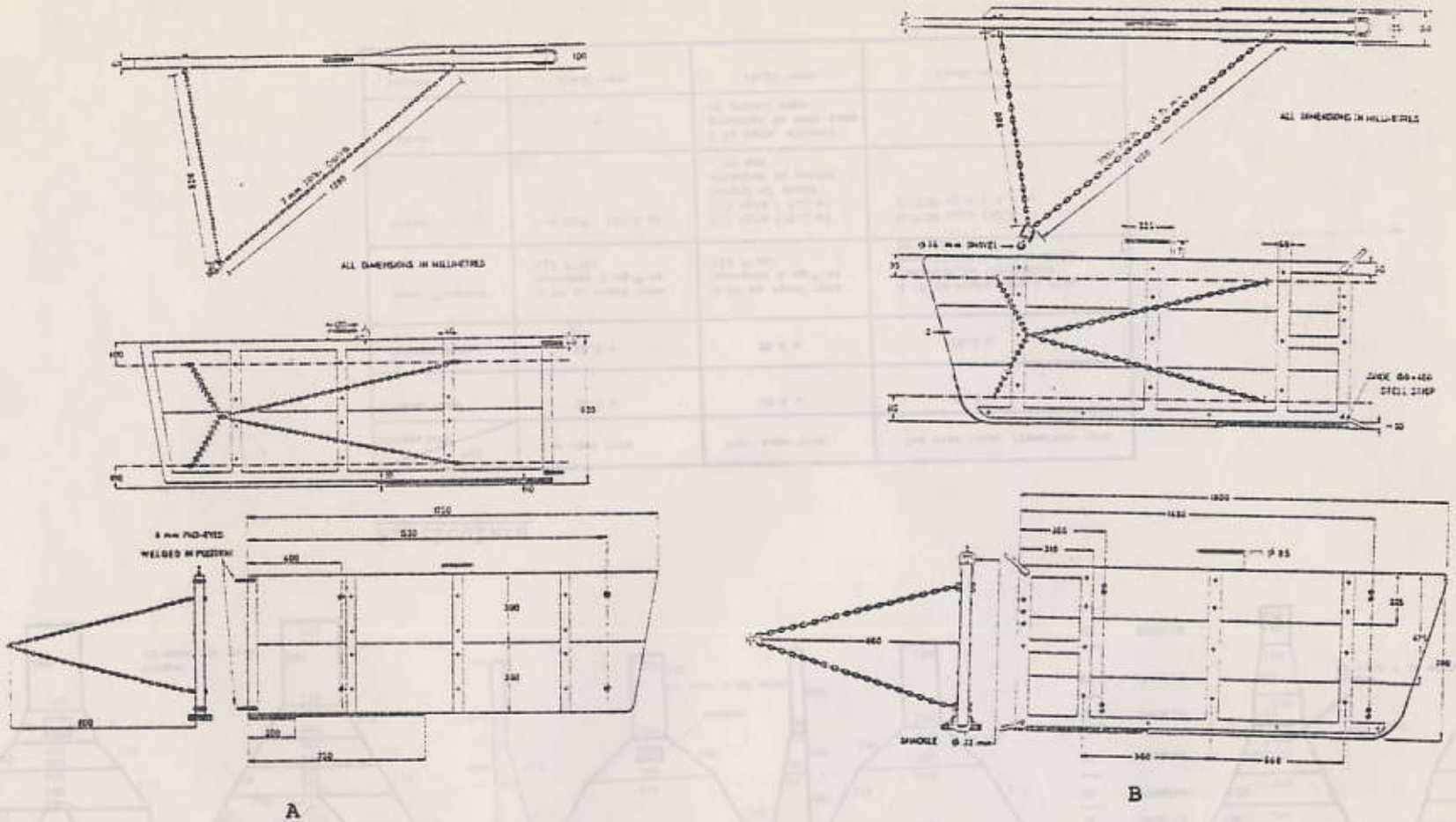


Fig. 2. Otter board used for first experiment (A), and for second and third experiments (B)

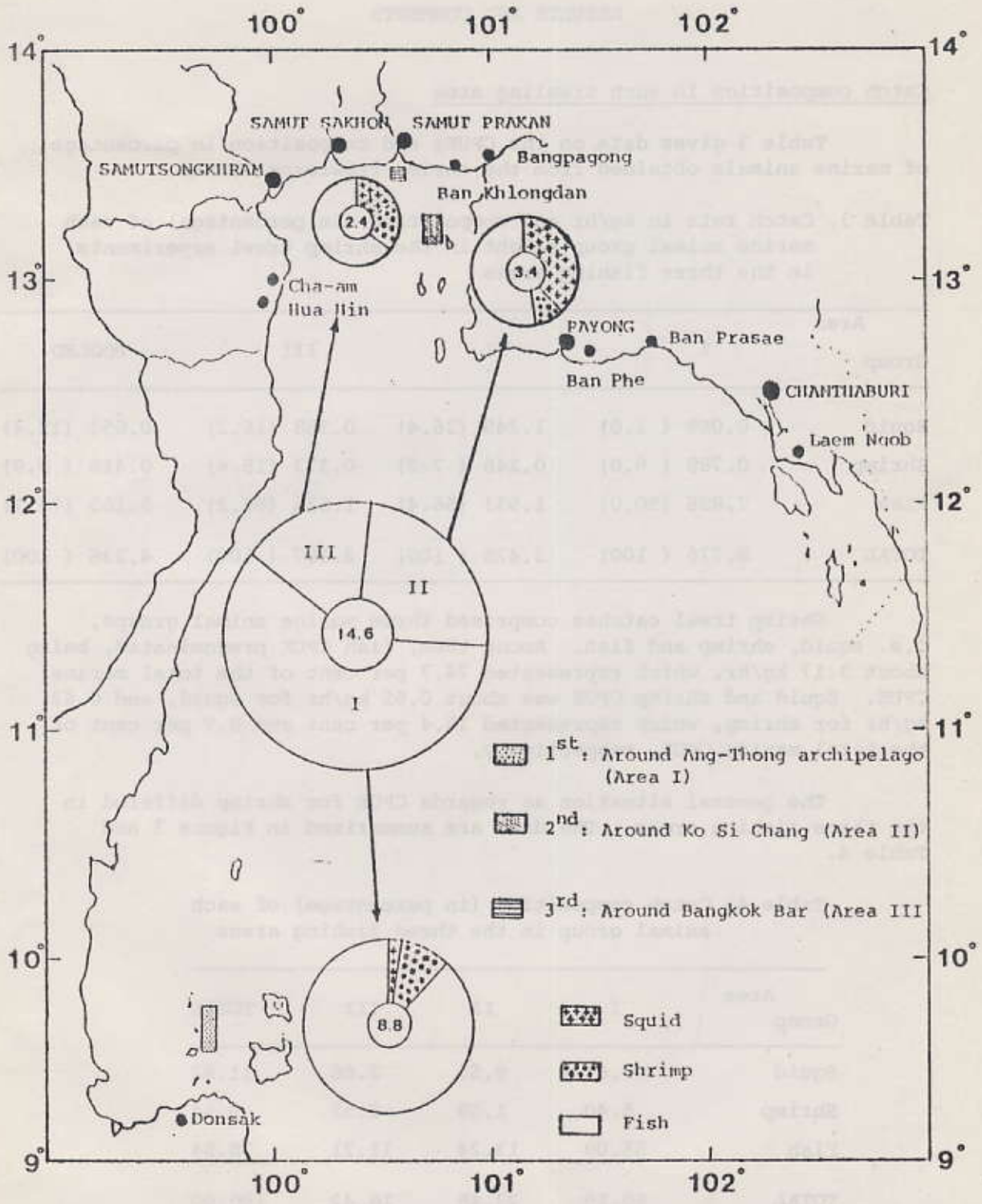


Fig. 3. Areas of shrimp trawl experiments in the Gulf of Thailand and catch composition, 1983-1984. The number in the center of each circle shows catch rate (kg/hr) for total marine animals.

RESULTS AND COMMENTS

Catch composition in each trawling area

Table 3 gives data on the CPUEs and composition in percentage of marine animals obtained from the shrimp trawlexperiments.

Table 3. Catch rate in kg/hr and composition (in percentage) of each marine animal group caught in the shrimp trawl experiments in the three fishing areas

Group \ Area	I	II	III	POOLED
Squid	0.089 (1.0)	1.249 (36.4)	0.388 (16.2)	0.653 (15.4)
Shrimp	0.789 (9.0)	0.246 (7.2)	0.373 (15.6)	0.418 (9.9)
Fish	7.898 (90.0)	1.933 (56.4)	1.636 (68.2)	3.165 (74.7)
TOTAL	8.776 (100)	3.428 (100)	2.397 (100)	4.236 (100)

Shrimp trawl catches comprised three marine animal groups, i.e. squid, shrimp and fish. Among them, fish CPUE predominated, being about 3.17 kg/hr, which represented 74.7 per cent of the total marine CPUE. Squid and shrimp CPUE was about 0.65 kg/hr for squid, and 0.42 kg/hr for shrimp, which represented 15.4 per cent and 9.9 per cent of the total marine CPUE, respectively.

The general situation as regards CPUE for shrimp differed in the three fishing areas. The data are summarized in Figure 3 and Table 4.

Table 4. Catch composition (in percentage) of each animal group in the three fishing areas

Group \ Area	I	II	III	TOTAL
Squid	0.61	8.55	2.66	11.82
Shrimp	5.40	1.69	2.55	9.64
Fish	55.09	13.24	11.21	78.54
TOTAL	60.10	23.48	16.42	100.00

Area I

In this area, total marine CPUE (8.78 kg/hr) is the highest among the three fishing areas. Fish CPUE is conspicuous, with 54 per cent of all marine CPUE in all fishing areas. Shrimp CPUE follows with 5.4 per cent of total catch. Squid CPUE can be disregarded because it is negligible in comparison with other animal CPUE.

Therefore, it would appear that this area is the best fishing ground as far as shrimp catch is concerned.

Area II

Fishing and squid CPUEs are conspicuous, but shrimp CPUE is extremely small. Therefore the shrimp trawl experiments showed this area to be an unproductive area for shrimp.

Area III

This area is the least productive area for total marine CPUE. However, as regards shrimp CPUE, it ranks second after Area I, and reaches almost the same level as squid CPUE. Therefore the shrimp trawl experiments showed that this is a fairly good area for shrimp because of the low diversity in occurrence of the three animal groups.

Comparison of the catch between different types of net

Analysis of variance was applied for the test of differences in CPUE (Table 5). Throughout the three experiments conducted in the three areas, four types of net were used in Areas I and II, and six types of net in Area III.

Table 5. Two-way analysis of variance in catch rate three marine animal groups in the three fishing areas

a) Area I

Source of Variance	d.f.	Variance ratio		
		Shrimp	Fish	Total catch
Nets (4)	3	3.244	3.811*	3.314
Fishing time (3)	2	2.573	1.157	0.846
Collective error	6	2.585	2.359	2.425

b) Area II

Source of Variance	d.f.	Variance ratio			
		Squid	Shrimp	Fish	Total catch
Nets (4)	3	0.021	1.728	1.055	2.059
Fishing time (3)	2	1.994	0.524	2.285	8.172**
Collective error	6	0.399	1.293	1.362	3.908*

Source of Variance	d.f.	Variance ratio			
		Squid	Shrimp	Fish	Total catch
Nets	3	3.547	4.000*	3.239	6.700**
Fishing time	2	0.219	1.826	3.386	4.557*
Collective error	6	2.813	0.913	0.946	2.047

c) Area III

Source of Variance	d.f.	Variance ratio			
		Squid	Shrimp	Fish	Total catch
Nets (6)	5	4.848**	25.067**	2.814	2.855*
Fishing time (3)	2	1.391	2.133	1.211	0.647
Collective error	10	2.543*	1.133	1.873	4.498**

Notes: Nets : N_1, N_2, N_3, N_4, N_5, and N_6

Fishing time : Evening, night and morning

* : $0.01 < p < 0.05$, ** : $p < 0.01$

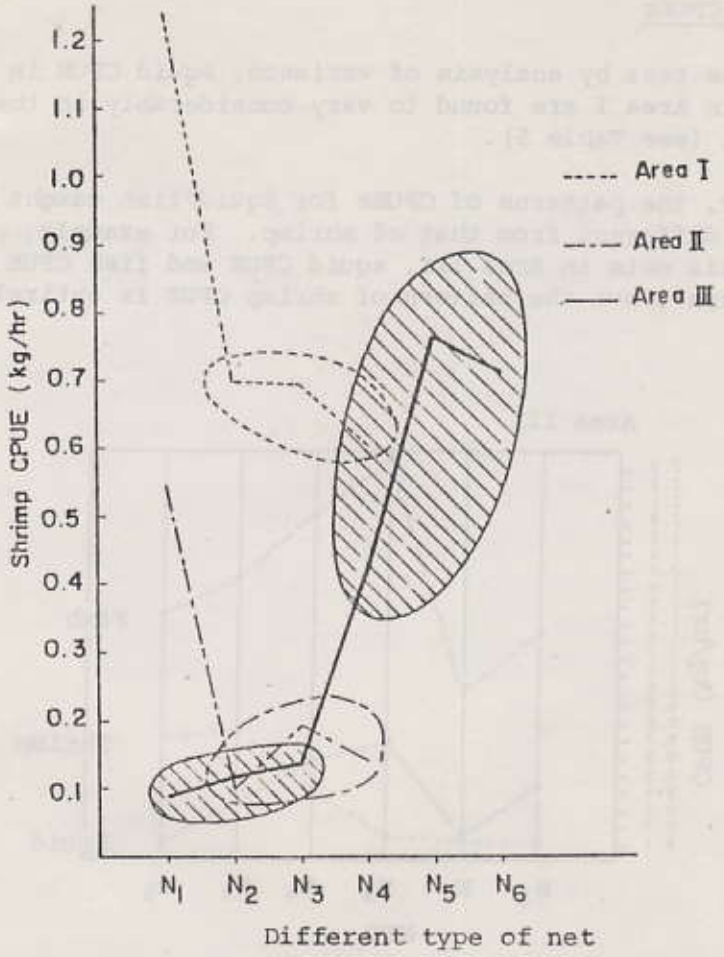


Fig. 4. Differences in catch between the nets by fishing area in the Gulf of Thailand

The differences in shrimp CPUEs by net in each fishing area, as shown in Figure 4, are:

(1) In Areas II and III, the CPUEs of the three nets (N_2, N_3 and N_4) are nearly the same;

(2) In Area III, there is a significant difference in CPUEs between the two groups of net i.e. N_1-N_3 and N_4-N_6 (shaded in Figure 4).

Thus, in general N -N type nets, particularly the two-seam commercial nets (N_5 and N_6), may be more effective than the N_1-N_3 types for shrimp catch.

Squid and fish CPUEs

From the test by analysis of variance, squid CPUE in Area III and fish CPUE in Area I are found to vary considerably in the catch by different nets. (see Table 5).

However, the patterns of CPUEs for squid/fish caught by different nets are quite different from that of shrimp. For example, when plotting the CPUEs for six nets in Area III, squid CPUE and fish CPUE show nearly the same patterns*, but the pattern of shrimp CPUE is entirely different (Figure 5).

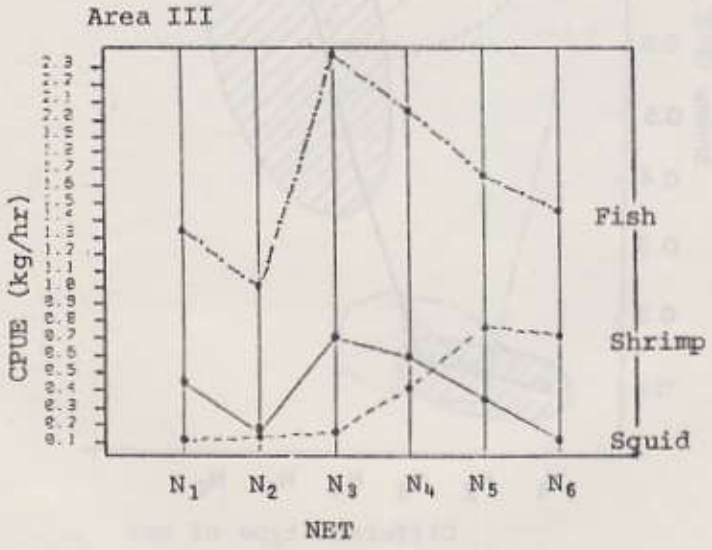


Fig. 5. Plot of CPUEs by net for three marine animal groups

The varying patterns of CPUEs by nets for squid/fish and for shrimp may be due to the differences in movements against the nets or in body shape between squid/fish and shrimp.

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* In squid/fish CPUEs, N_3-N_4 types, particularly four-seam net without window (N_3), seem to be the most effective.

Comparison of catch at different fishing times

Although the analysis of variance reveals no significant differences for shrimp, squid and fish CPUEs (see Table 5), the CPUE value for each animal group fluctuates by fishing time as well as by fishing area (Figure 6).

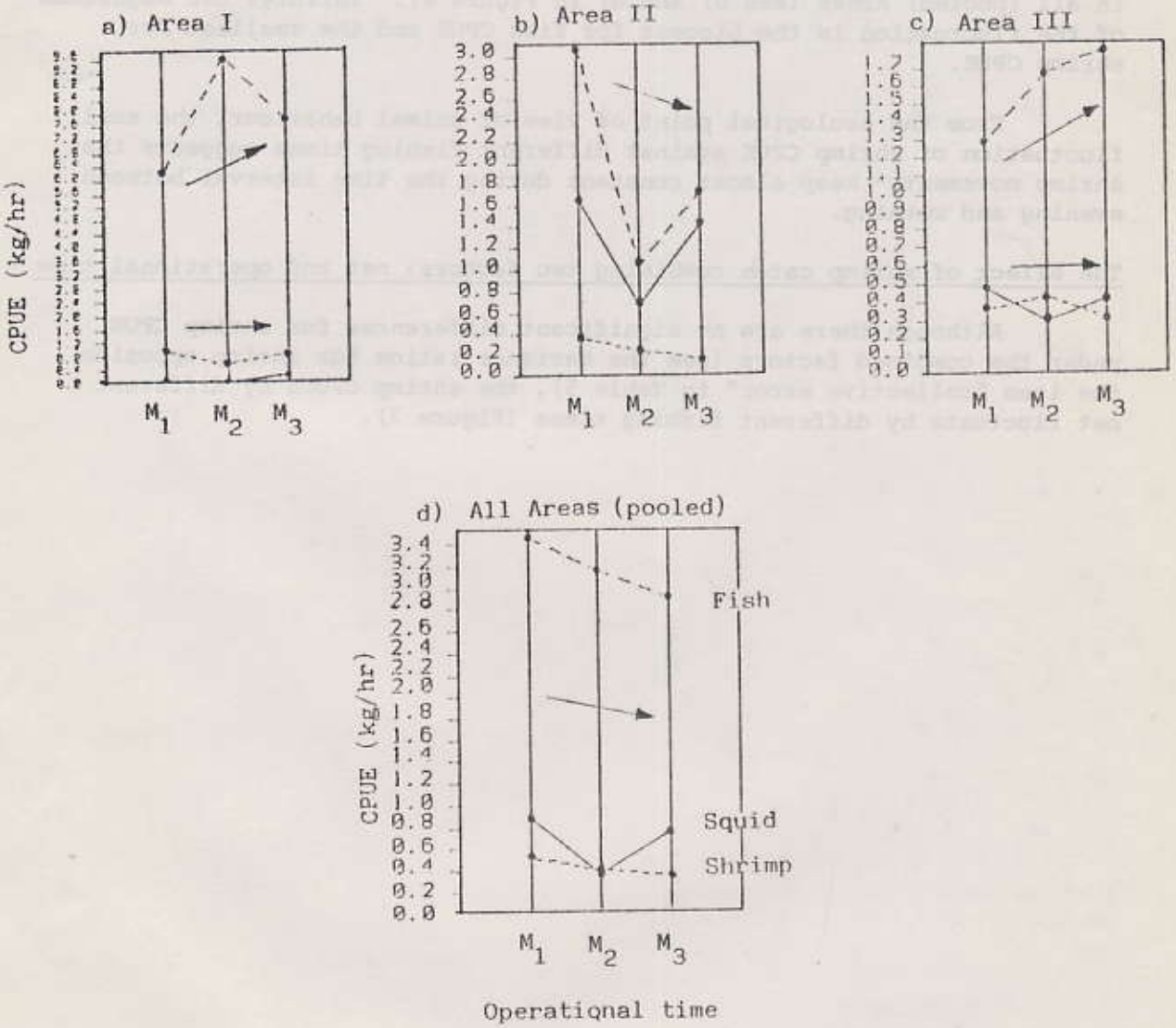

Fig. 6. Catch variation by operational time in each fishing area. Arrows indicate the fluctuation pattern of each CPUE.

From Figure 6, we can infer the following three patterns of CPUE fluctuation. First, both in Areas I and III (a) and c) in Fig.6), fish CPUE showed an increasing trend as the operational time shifted from evening (M_1) to morning (M_3), whereas the CPUEs for shrimp and squid remained almost constant. Secondly, in Area II all CPUEs showed downward trends as the operational time shifted from evening to morning, and these downward trends almost coincided with the fluctuation of CPUEs in all (pooled) Areas (see b) and d) in Figure 6). Thirdly, the magnitude of the fluctuation is the biggest for fish CPUE and the smallest for shrimp CPUE.

From the ecological point of view of animal behaviour, the small fluctuation of shrimp CPUE against different fishing times suggests that shrimp movements* keep almost constant during the time interval between evening and morning.

The effect of shrimp catch combining two factors: net and operational time

Although there are no significant differences for shrimp CPUE under the combined factors (see the variance ratios for shrimp opposite the item "collective error" in Table 5), the shrimp CPUEs by different net fluctuate by different fishing times (Figure 7).

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* It is a well known fact that shrimps tend to aggregate or show full activity during darkness. This means that catches of shrimps are generally plentiful during the night.

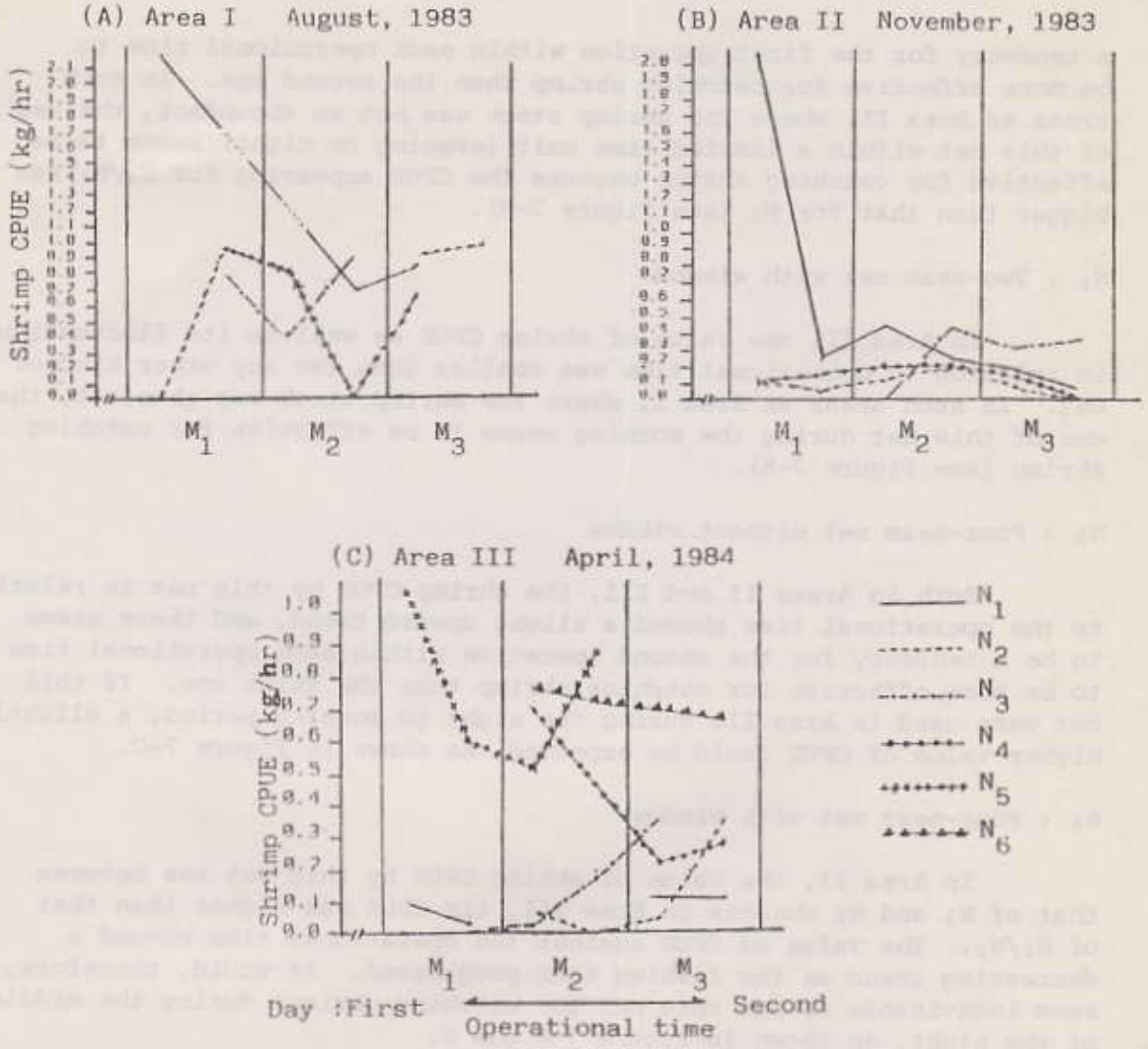

Fig. 7. Plot of shrimp CPUE by different nets at different operational times. Trawling was generally conducted twice within each operational time.

Although the data were collected on a different basis as regards time (sampling month and year) and space (sampling area), we can infer the following distinct characteristics of the nets which were used for shrimp trawls:

N_1 : Two-seam net without window

Both in Area I and Area II, the shrimp CPUE by this net fluctuated widely in relation to the operational time. There seems to be

a tendency for the first operation within each operational time to be more effective for catching shrimp than the second one. In such areas as Area II, where the shrimp stock was not so aboundant, the use of this net within a limited time unit (evening or night) seems to be effective for catching shrimp because the CPUE appearing for M_1/M_2 was bigger than that for M_3 (see Figure 7-B).

N_2 : Two-seam net with window

In Area II, the value of shrimp CPUE as well as its fluctuations in relation to operational time was smaller than for any other kind of net. In such areas as Area I, where the shrimp stock was abundant, the use of this net during the morning seems to be effective for catching shrimp (see Figure 7-A).

N_3 : Four-seam net without window

Both in Areas II and III, the shrimp CPUE by this net in relation to the operational time showed a slight upward trend, and there seems to be a tendency for the second operation within each operational time to be more effective for catching shrimp than the first one. If this net were used in Area III during the night to morning period, a slightly higher value of CPUE could be expected, as shown in Figure 7-C.

N_4 : Four-seam net with window

In Area II, the value of shrimp CPUE by this net was between that of N_1 and N_2 whereas in Area III, its CPUE was higher than that of N_1/N_2. The value of CPUE against the operational time showed a decreasing trend as the fishing time progressed. It would, therefore, seem indavisable to use this net for catching shrimps during the middle of the night, as shown in Figure 7-A and C.

N_5 : Two-seam commercial net without window

Although this net was tested only in Area III, a fairly high value (about 0.8 kg/hr) of shrimp CPUE was expected during the evening to night operation. The variation of CPUE, in terms of coefficient of variance (C.V.) against the operational time, also showed a high value of 0.32.

N_6 : Two-seam commercial net with window

Experimental trawling by this net was conducted only in Area III. The value of shrimp CPUE by this net, however, showed a constantly high level of about 0.7 kg/hr. Therefore, this net, as well as N_5, may be effective for catching shrimp.

DISCUSSION AND CONCLUSTIONS

There are essential aspects concerning the differences in the efficiency of catch by different types of shrimp trawl net: i) the catching effect for each animal group including shrimp (species selection), and ii) the catching effect for different size (length) of individuals in the same animal group (size selection).

As regards aspect (i) two nets of N_5 and N_6, i.e., two-seam commercial nets without and with window, were used in the experiments*. These nets seem to be the most suitable for catching shrimp only, because the CPUE values of squid/fish caught by these nets were lower than the CPUE values of any other net, despite the big catch of shrimp by N_5/N_6 (see Figure 5).

As regards the effect of the net, with and without a window, however it cannot be definitely established at this stage because there was no significant difference in catch by these two types of net.

Figure 8 gives the length frequency distribution for shrimp and fish found in the catch by different types of net.

As regards aspect (ii), the modes of body length for fish caught by N_5/N_6 were significantly smaller than those caught by any other net. The modes of body length for shrimp caught by different types of net, however, showed no significant differences (Table 6). This suggests that the catch by N_5/N_6 may be more selective for fish than for shrimp itself.

It is, however, noteworthy that the body lengths of shrimp/fish caught by N_5/N_6 concentrated in the smaller-sized individuals (Table 6 and Figure 8).

In conclusion, as far as the catch is concerned, the use of N_5/N_6 would be more effective for shrimp than any other net, but at the same time, those nets (N_5/N_6) would be effective in catching small-sized fish.

Table 7 gives our conclusions derived from the shrimp trawl experiments, using different types of net.

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* The main purpose of the experiments was how to improve the efficiency of catch for shrimp without juveniles/young of economical important marine animal groups being included in the catch.

Table 6. Catch (both in weight and number), range of body length in catch and mode in catch for shrimp and fish caught in Area III

a) Shrimp

Net	Catch in kg	Catch in number	Range of body size in catch	Mode in cm	%
N_1	0.36	107	3-19	5-6	50
N_2	0.47	82	3-15	4-6	55
N_3	0.56	172	4-15	6-7	55
N_4	1.67	421	4-20	5-8 (6-7)	89 (45)
N_5	3.07	1817	3-13	4-7 (5-6)	90 (35)
N_6	2.84	1999	3-12	4-7 (5-6)	90 (42)

b) Fish

N_1	5.35	400	5-23	9-10	62
N_2	3.93	264	5-25	9-10	67
N_3	9.38	314	6-30	9-10	54
N_4	8.18	459	2-30	9-10	53
N_5	6.60	1339	2-25	4-8 (5-7)	71 (44)
N_6	5.83	1807	2-19	4-8 (5-7)	85 (52)

The common size appearing in the catches are shown in parentheses.

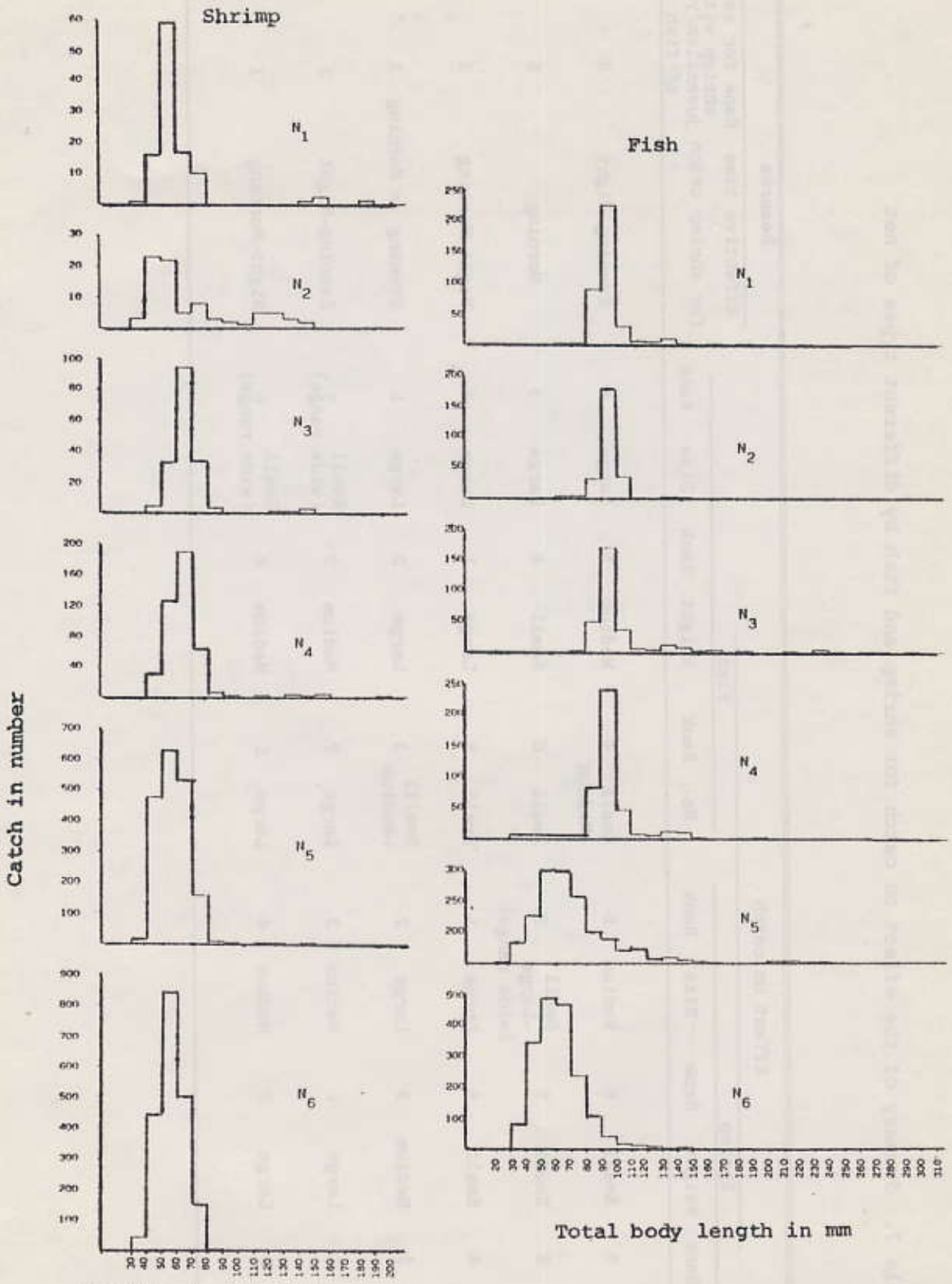

Fig. 8. Length frequency distribution for shrimp and fish found in the catch by different type of net.

Table 7. Summary of the effect on catch for shrimp and fish by different types of net

Net	Effect on catch												Remarks	
	Shrimp						Fish						Effective time for shrimp catch	Rank for catching shrimp without juveniles/young of fish
	No.	Rank	Weight	Rank	Size	Rank	No.	Rank	Weight	Rank	Size	Rank		
N_1	Small	5	Small	6	Medium	5	Small -Medium	4	Medium	5	Large	4	Evening-Night	5
N_2	Small	6	Small	5	Small -Large (wide range)	6	Small	6	Small	6	Large	3	Morning	5
N_3	Small	4	Small	4	Large	1	Small	5	Large	1	Large	2	Night-Morning	3
N_4	Medium	3	Medium	3	Large	2	Smalll -Medium	3	Large	2	Large	1	Evening or Morning	3
N_5	Large	2	Large	1	Medium	3	Large	2	Medium	3	Small (wide range)	5	Evening-Night	1
N_6	Large	1	Large	2	Medium	4	Large	1	Medium	4	Small (wide range)	6	Night-Morning	1

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Appendix Table 1. Catch (kg/hr) for each marine animal group, by different net and fishing time units

1st experiment (Area I)

Net	N_1			N_2				N_3			N_4			
Fishing Time / Group	M_1	M_2	M_3	M_1		M_3		M_1	M_2		M_1	M_2		M_3
Squid	0.265	0	0.96	0	0	0	0	0	0	0	0	0	0	0
Shrimp	2.16	0.72	0.84	0	0.96	0.89	0.96	0.78	0.42	0.89	0.96	0.81	0	0.66
Fish	5.80	2.37	9.43	3.74	11.84	15.17	4.14	1.74	3.86	6.38	10.23	13.46	22.00	2.42
Total	6.24	3.09	11.23	3.74	12.80	16.06	5.10	2.52	4.28	7.27	11.19	14.27	22.00	3.08

2nd experiment (Area II)

Net	N_1						N_2						N_3						N_4					
Fishing Time / Group	M_1		M_2		M_3		M_1		M_2		M_3		M_1		M_2		M_3		M_1		M_2		M_3	
Squid	3.401	0.637	0.590	0.275	1.701	1.139	0.604	3.349	0.087	0.334	0.571	1.868	0.475	1.768	1.767	0.027	1.802	1.569	0.748	1.979	1.012	1.228	1.887	0.951
Shrimp	2.051	0.255	0.459	0.261	0.199	0.072	0.119	0.060	0.123	0.212	0.080	0	0.009	0.006	0	0.454	0.323	0.368	0.105	0.166	0.202	0.220	0.146	0.022
Fish	1.249	8.510	0.817	0.932	0.712	0.147	3.737	1.551	0.744	0.434	0.886	0.882	0.462	0.344	0	0.163	2.406	4.314	1.842	6.636	1.819	3.314	1.755	2.736
Total	6.701	9.402	1.866	1.468	2.612	1.358	4.460	5.160	0.954	0.980	1.537	2.750	0.946	2.118	1.767	0.644	4.531	6.251	2.695	8.781	3.033	4.762	3.788	3.709

3rd experiment (Area III)

Net	N_1				N_2				N_3				N_4				N_5				N_6			
Fishing Time / Group	M_1		M_3		M_2		M_3		M_1	M_2		M_3	M_2		M_3		M_1		M_2		M_2		M_3	
Squid	1.100	0.150	0.110	0.370	0.230	0.130	0.150	0.100	0.040	0.530	1.030	1.220	0.190	0.490	0.680	0.980	0.740	0.383	0.133	0.122	0.157	0.036	0.086	0.143
Shrimp	0.100	0.030	0.120	0.110	0.070	0	0.050	0.353	0	0.025	0.175	0.362	0.700	0.466	0.224	0.277	1.066	0.604	0.521	0.578	0.764	0.720	0.695	0.664
Fish	0.730	0.890	2.850	0.880	0.350	0.780	1.300	1.500	0.660	2.340	2.930	3.447	0.920	3.256	2.424	1.581	2.421	1.758	1.458	0.980	1.686	1.935	1.415	0.793
Total	1.930	1.070	3.080	1.360	0.650	0.910	1.500	1.953	0.700	2.895	4.135	5.029	1.810	4.212	3.328	2.535	4.227	2.745	2.092	1.980	2.607	2.691	2.196	1.[illegible]

Appendix Table 2.

Average catch rate (kg/hr) and percentage for each animal group, by different nets

a) Area I

Net / Group	N_1		N_2		N_3		N_4		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.415	6.1	0	0	0	0	0	0	0.089	1.0
Shrimp	1.240	18.1	0.703	7.5	0.697	14.9	0.607	4.8	0.789	9.0
Fish	5.200	75.8	8.722	92.5	3.993	85.1	12.028	95.2	7.898	90.0
Total	6.855	100	9.425	100	4.690	100	12.635	100	8.776	100

b) Area II

Net / Group	N_1		N_2		N_3		N_4		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	1.291	33.1	1.169	44.3	1.235	45.6	1.301	29.2	1.249	36.4
Shrimp	0.549	14.1	0.099	3.7	0.193	7.1	0.144	3.2	0.246	7.2
Fish	2.061	52.8	1.372	52.0	1.282	47.3	3.017	67.6	1.933	56.4
Total	3.901	100	2.640	100	2.710	100	4.462	100	3.428	100

c) Area III

Net / Group	N_1		N_2		N_3		N_4		N_5		N_6		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.433	23.3	0.152	12.2	0.705	22.1	0.585	19.2	0.345	12.5	0.106	4.6	0.388	16.2
Shrimp	0.090	4.8	0.118	9.4	0.141	4.4	0.417	13.7	0.767	27.8	0.711	31.3	0.373	15.6
Fish	1.337	71.9	0.983	78.4	2.344	73.5	2.045	67.1	1.649	59.7	1.457	64.1	1.636	68.2
Total	1.860	100	1.253	100	3.190	100	3.047	100	2.761	100	2.274	100	2.397	100

d) All areas (pooled)

Net / Group	N_1		N_2		N_3		N_4		N_5		N_6		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.824	20.8	0.545	13.0	0.787	23.7	0.725	11.3	0.345	12.5	0.106	4.6	0.653	15.4
Shrimp	0.567	14.4	0.276	6.6	0.293	8.9	0.354	5.5	0.767	27.8	0.711	31.3	0.418	9.9
Fish	2.563	64.8	3.361	80.4	2.234	67.4	5.314	83.2	1.649	59.7	1.457	64.1	3.165	74.7
Total	3.954	100	4.182	100	3.314	100	6.393	100	2.761	100	2.274	100	4.236	100

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Appendix Table 3. Average catch rate (kg/hr), and percentage for each animal group, by different operational times

a) Area I

Fishing Time / Group	M1		M2		M3		pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.057	0.8	0	0	0.240	2.7	0.089	1.0
Shrimp	0.972	13.3	0.568	5.6	0.838	9.5	0.789	9.0
Fish	6.270	85.9	9.614	94.4	7.789	87.8	7.900	90.0
Total	7.299	100	10.182	100	8.867	100	8.778	100

b) Area II

Fishing Time / Group	M1		M2		M3		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	1.645	32.7	0.665	34.4	1.436	43.3	1.249	36.4
Shrimp	0.346	6.9	0.241	12.5	0.151	4.6	0.246	7.2
Fish	3.041	60.4	1.028	53.1	1.730	52.1	1.933	56.4
Total	5.032	100	1.934	100	3.317	100	3.428	100

c) Area III

Fishing Time / Group	M1		M2		M3		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.482	22.6	0.304	12.7	0.427	16.8	0.387	16.2
Shrimp	0.360	16.9	0.432	18.0	0.317	12.5	0.374	15.6
Fish	1.292	60.5	1.662	69.3	1.798	70.7	1.636	68.2
Total	2.134	100	2.398	100	2.542	100	2.397	100

d) All pooled areas

Fishing Time / Group	M1		M2		M3		Pooled	
	Average catch	%	Average catch	%	Average catch	%	Average catch	%
Squid	0.881	18.1	0.364	9.3	0.775	19.2	0.653	15.4
Shrimp	0.524	10.8	0.395	10.1	0.353	8.7	0.418	9.9
Fish	3.452	71.1	3.169	80.7	2.914	72.1	3.165	74.7
Total	4.857	100	3.928	100	4.042	100	4.236	100